a3 concld

vicinity of the resonant frequency. In this application, the influences of the environment on the resonant frequency are kept as constant as possible by a hermetically sealed housing that is either filled with a protective gas or is evacuated. On the other hand, piezoelectric resonators are used as sensor elements, whereby from the measured changes of the resonance characteristics, conclusions are drawn concerning the physical or, respectively, chemical characteristics, or, respectively, the chronological modification thereof, of the environment. In both areas of application, a mounting and electrical contacting of the resonator is required--

On page 1, line 23, please insert the new rewritten paragraph:

a4

--In the case of the frequency standard, the resonator is standardly mounted in standardized housings, whereby the electrodes are glued to the supply lines in electrically conductive fashion, and the resonator therefore cannot be exchanged. In the case of the microbalance sensor application (QCM Quartz Crystal Microbalance), the resonator (thickness shear mode) is built into correspondingly constructed mounts, which standardly can be disassembled. The resonator is thereby electrically contacted at both main surfaces, and held stably in position, using resilient contact elements that exert holding forces (Fig.1) that act axially on the resonator, thus also pressing the resonator against the mounting part connected to ground potential (for example, the microbalance sensor mount of the company Leybold Inficon).--

On page 2, line 1, please insert the new rewritten paragraph:

a5

--Given this 'axial' electrical contacting or, respectively, mounting, temperature variations result not only in different thermal expansions between the main surface of the resonator and the mount, but also in changes of the contact forces of the spring elements, and thus in undefined transition resistances. In order to minimize as far as possible thermally caused influences on the resonant frequency, temperature-compensated blanks (e.g., quartz AT blanks) are used, and also the mount is cooled or, respectively, thermostatized during the measurement.--

On page 2, line 7, please insert the new rewritten paragraph:

a6

--An axial contacting is also present in the mount of the piezoelectric resonator according to DE 34 27 646 A, in which the resonator lies with one of its main surfaces on lugs of the resonator mount and is fixed thereon by gluing. Here as well, the oscillation

A6 concl'd

characteristics of the crystal are therefore influenced in an undesired manner by axial electrical contacting and mounting. The mount according to JP 57-92913 A is similar both in its construction and also in its negative effects on the oscillation characteristics of the resonator. Here as well, a discoid resonator lamina is positioned and fixed by axial application and gluing with the mounting elements; additional positioning aids also being present on said mounting elements in the form of elements abutting the lateral surfaces of the resonator.--

On page 2, line 16, please insert the new rewritten paragraph:

A7

--Finally, mention is also made of the construction stated and presented as prior art in the cited Japanese laid open print, in which two mounting lugs are present having parallel longitudinal slits for the installation of the resonator lamina. The lower, and if necessary also the upper, main surface of the resonator lamina lies on the edge of the longitudinal slit with a part of its main surface, so that here as well a negative influence on the oscillation characteristics is possible, in particular given the (typically likewise provided) gluing of the resonator lamina to the mounting lugs.--

On page 2, line 24, please insert the new rewritten paragraph:

A8

--The object of the invention is to propose a simple arrangement for the mounting or, respectively, electrical contacting of a piezoelectric resonator in which the oscillation and resonance characteristics remain as free as possible of influence from the mounting or, respectively, electrical contacting. In addition, this advantage is to be provided over a large temperature range, in order thereby also to minimize the temperature-caused hysteresis of the resonance characteristics.--

On page 2, line 30, please insert the new rewritten paragraph:

A9

--The first object is solved according to the present invention in that the mounting elements abut immediately and directly on the resonator, and fix the resonator in the arrangement without the use of an adhesive, and in that the points of electrical contact of the mounting elements with the resonator lie essentially in one plane, said plane being essentially parallel to the plane of the resonator, and in that the mounting and electrical contacting forces exerted by the mounting elements lie essentially parallel to the plane of the resonator. The use

a^{9} cont'd

of the resonator is thereby significantly simplified, because no additional gluings need be provided that form an intermediate layer between the mounting elements and the resonator material. The mounting forces, and also the electrical contacting forces, are already given by the mounting elements alone. This also enables the resonator to be exchanged in a simple manner without destruction. In addition, diffusion effects between the glue and the electrodes are prevented that occur given use at high temperatures and that have an influence on the resonant frequencies. Both for thickness shear and for thickness extension resonators, an arrangement thereby results in which the mounting and electrical contacting forces act parallel to the node plane of the main oscillation, which can be excited piezoelectrically, whereby these forces also influence the oscillation characteristics only to the smallest possible degree. Of course, at least one of the mounting elements is here also advantageously constructed from one essentially rigid part and one part that can essentially be elastically deformed, the latter part being located closer to the base structure.--

On page 3, line 17, please insert the new rewritten paragraph:

a^{10}

--According to an additional feature of the invention, the mounting elements can thereby lie immediately and directly on the lateral surface, or on one of the lateral surfaces, of the resonator, by which means it is possible to avoid all axial force components on the main surfaces of the resonator lamina, and thereby also to avoid all negative influencing of the oscillation characteristics of the resonator.--

On page 3, line 22, please insert the new rewritten paragraph:

a^{11}

--Advantageously, the points of contact of the mounting elements with the resonator are provided exclusively on the lateral surface, or, respectively, one of the lateral surfaces, of the resonator. That is, the contact points are for example fashioned complementary to the lateral surface or surfaces, or the contact points comprise mounting structures in which resonator laminae can be used having, in principle, any construction of the lateral surfaces for example, needle-shaped points forming a multipoint mounting, or the like.--

On page 3, line 28, please insert the new rewritten paragraph:

a^{12}

--According to a further advantageous specific embodiment of the invention, the mounting and electrical contacting forces exerted by the mounting elements are directed essentially radially towards the center of the resonator.--

On page 3, line 31, please insert the new rewritten paragraph:

A13

--In order to keep the mounting forces, and also the electrical contacting forces, essentially constant over the entire range of temperatures that will be encountered during use, and also to enable compensation of manufacturing tolerances in the dimensions of the resonator, according to another feature of the invention at least one of the mounting elements is mounted elastically or, respectively, is connected elastically with the base structure.--

On page 4, line 3, please insert the new rewritten paragraph:

A14

--In an advantageous specific embodiment of the invention, it is provided that at least one of the mounting elements is made up of one essentially rigid part and one part that is essentially elastically deformable, whereby the elastic part is located closer to the base structure. In such arrangement, those parts of the mounting arrangement that are responsible for the magnitude of the mounting forces are arranged outside the region in which temperature changes preferably occur. Here as well, the mounting and electrical contacting forces can be kept essentially constant over the entire application temperature range, and the tolerances can be compensated. For example, given sensor arrangements in which there results a heating of the volume around the resonator, or of the resonator itself, during operation, the elastic part is located at a distance therefrom, so that the heating can act only to a small extent, or not at all, on the mechanical and elastic characteristics of the elastically deformable part of the mounting arrangement. For this reason, the temperature response of the resonant frequency of a piezoelectric resonator in the inventive mount arrangement is influenced only slightly by the mount, and the hysteresis of the resonant frequency is reduced in a temperature range from room temperature up to approximately 700°C.--

On page 4, line 18, please insert the new rewritten paragraph:

A15

--According to an advantageous specific embodiment of the invention, at least one of the mounting elements is constructed as an oblong mounting arm having at least one essentially rigid longitudinal segment and one segment that is essentially elastically deformable, whereby a good mounting effect and shape endurance is achieved, in particular given the arrangement of the rigid segment at the resonator, and the resonator can be put in place and exchanged easily, since at least one essential segment of the mounting arm can be moved to the side (e.g. by using a special installation equipment) for this purpose.--

On page 5, line 17, please insert the new rewritten paragraph:

a16 --The object of the present invention is also achieved by an arrangement having a resonator in which at least one of the main surface regions is provided with at least one excitation electrode that covers at least a part of this main surface region, whereby an electrically conductive strip extends from the electrode essentially radially in the direction of the edge of the main surface region, and extends up to the lateral surface of the resonator. It is thereby no longer necessary to provide a clamping, or even only an electrical contacting, with a force acting normally on the main surface, or on each main surface, of the resonator having an electrode, in a region thereof that can have an adverse effect on the oscillations characteristics. In an arrangement as specified above, the resonator constructed in this way can be mounted such that the resonance characteristics remain as free as possible of influence from the mounting or, respectively, electrical contacting, and the hysteresis, caused by temperature, of the resonance characteristics is minimized. In addition, the cited features enable the advantageous radial clamping of the resonator while avoiding the electrical contacting of the resonator immediately on the main surface regions, in advantageous combination with the purely radial mounting and clamping of the resonator.--

On page 6, line 5, please insert the new rewritten paragraph:

a17 --FIG. 2 is a top view of a circular resonator lamina embodying the principles of the present invention and having electrodes and a conductive segment extending up to the lateral surface thereof.--

On page 6, line 8, please insert the new rewritten paragraph:

a18 --FIG. 3 is a side view of the lamina of FIG. 2 with an essentially radial mount.--

On page 6, line 10, please insert the new rewritten paragraph:

a19 --FIG 4 is an arrangement having mounting arms that are oriented parallel to the resonator lamina.--

On page 6, line 16, please insert the new rewritten paragraph:

a20 --Although other shapes are possible, the preferred shape for piezoelectric resonators, in particular for microbalance sensor applications and as frequency standards, is the flat, essentially disk-shaped construction shown in the drawings. Electrodes 2 are thereby applied

A20 cont'd

on the circular resonator lamina 1, as can be seen particularly clearly in FIG. 1. In microbalance arrangements, these electrodes 2 can be provided as a collector and counter-electrode. Of course, it is also possible for only one electrode to be present on one side of the resonator lamina 1. The electrode 2, or at least one electrode 2, is applied up to a point close to the edge of the resonator 1. According to the prior art, in an arrangement such as that shown in FIG. 1, the mounting forces or, respectively, electrical contact forces FR at the edge of the resonator in the axial direction therefore act in normal fashion on the node plane of the piezoelectrically excitable main oscillation (thickness shear oscillation or, respectively, thickness extension oscillation).--

On page 6, line 28, please insert the new rewritten paragraph:

SUB B2 A21

--In contrast, according to the present invention it is provided that, as shown in FIG. 2, the resonator lamina or plate 1 is borne at its edge by mounting elements that cause forces FR that act radially on the resonator lamina at least two clamping points 3. In this case, the force vectors FR lie in the node plane of the piezoelectrically excitable main oscillation (thickness shear oscillation or, respectively, thickness extension oscillation). In the resonator 1, the electrodes 2, which cover only a part of the main surface(s) of the lamina 1, are then preferably provided with conductive strips, called contact lugs 3, which extend out to the lateral surface of the resonator lamina. In this construction of the electrodes, the resonator 1 is held at its edge by radially acting forces FR, and the electrical contact is also produced at the same time by contact surfaces on the mounting elements. In the inventive arrangement, the force vectors of the mounting forces preferably lie in the node plane of the piezoelectrically excitable main oscillation of the resonator, which comprises a corresponding crystallographic orientation. This holds both for thickness shear oscillations and for thickness extension oscillations.—

On page 7, line 11, please insert the new rewritten paragraph:

A22

--In FIG. 3, a resonator 1 is shown having two-way phase at its edge and having an electrode geometry similar to that shown in FIG. 2, but here the contact lugs 4 extend up to the node plane of the main oscillation that is to be excited piezoelectrically (thickness shear oscillation or, respectively, thickness extension oscillation). In this construction, the mounting or, respectively, electrical contacting forces (F) occur at the phase, whereby the resulting mounting or, respectively, electrical contact forces (FR) again lie parallel to the node plane of the main oscillation that is to be excited piezoelectrically, and therefore act

A22 concld

radially on the resonator lamina 1. The peripheral region of the resonator lamina 1, comprising the lateral surfaces, is not flat, but rather is constructed so as to run to an edge, so that, working together with corresponding structures in the mounting elements, a precisely defined orientation of the resonator 1 is determined and can be securely maintained. A construction of this sort also makes handling easier during installation and exchange of the resonator lamina 1, and makes tedious adjustments superfluous.--

On page 7, line 24, please insert the new rewritten paragraph:

A23

--FIG. 4 shows a possible arrangement in which the resonator lamina 1 is located in the plane defined by two oblong mounting arms 6, 7 positioned opposite one another. The mounting arm 6 is thereby of essentially rigid construction, and is preferably also connected fixedly with the base plate 10 of the base structure of the mounting arrangement, while the mounting arm 7, which is likewise essentially rigid, is connected with the base structure via an elastic element 8 or via an elastically deformable longitudinal segment, and in this way exerts holding forces, or, respectively, electrical contacting forces FR on the resonator lamina 1 that are maximally independent of temperature. The electrical contact to the electrodes 2 of the resonator is created via the terminal 9 and the mounting arms 6, 7.--

On page 8, line 8, please insert the new rewritten paragraph:

A24

--A further specific embodiment of an inventive mounting arrangement is shown in FIG. 6, in which a top view of a ceramic mounting arrangement is shown. Two oblong mounting arms 6 and 7 are thereby cut from a flat ceramic lamina and are therefore advantageously manufactured in one piece with the base structure 10, said base structure being formed by the segment of the ceramic lamina at the right in the drawing. The mounting arms 6, 7 are made up of two longitudinal segments, of which that longitudinal segment 6a, 7a that comes into contact with the resonator lamina 1, and is also located in the region of the greatest heating, is constructed with a larger cross-section and is therefore essentially rigid. The heating can often be desired and can thereby be particularly intensive, in particular in the case of sensor arrangements and microbalance arrangements. The longitudinal segments 6b, 7b located closer to the base structure 10 are constructed with a smaller cross-section and are therefore elastically deformable, and are responsible for the exertion of the mounting forces, and also the electrical contacting forces to the electrode 2, on the resonator lamina 1. Since they are located outside the region of the heating of the resonator lamina 1, and in addition can rapidly transmit the brought-in heat to the base structure 10, the mechanical and elastic

A24 concl.

characteristics thereof are influenced only slightly, or not all, by the temperature changes in the region of the resonator lamina 1.--

On page 9, line 8, please insert the new rewritten paragraph:

A25

--Also, via at least one excitation electrode 2 and at least two conductive strips 3, 4, and its conductive connection with at least two mounting arms 6, 7, or 11, the electrical resistance can be measured and can be used to obtain values of the temperature of the electrode and or the resonator lamina 1, respectively, in particular by using platin electrodes. Further, via the electrode and its conductive connection with the mounting arms 6, 7, or 11, the resonator lamina 1 can be heated or thermally stabilized by leading an electric current therethrough. This heating or thermal stabilizing could be in combination with an arrangement to measure the temperature of the resonator lamina or the area surrounding the resonator lamina and a calculation of the necessary, current value and control of the current source such that the exact required current value is supplied to the electrodes.--

In the abstract, please insert the new rewritten abstract:

SUB B1

A26

--A piezoelectric resonator arrangement comprises a mount having at least two mounting elements on a base structure and at least one laminar piezoelectric resonator that is clamped between the mounting elements, of which at least one impinges on the resonator with a force. In order to obtain the oscillation and resonance characteristics in a manner as free as possible of influence from the mounting or, respectively, electrical contacting, and over a large temperature range in order also to minimize the temperature-caused hysteresis of the resonance characteristics, the mounting elements abut immediately and directly on the resonator and contact and fix this resonator in the arrangement without the use of adhesive, and the points of electrical contact of the mounting elements with the resonator are located essentially in one plane that lies essentially parallel to the plane of the resonator, and, in addition, the mounting and electrical contacting forces exerted by the mounting elements lie essentially parallel to the plane of the resonator.--